The Integrated Weather Effects Decision Aid (IWEDA): Status and Future Plans

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The Integrated Weather Effects Decision Aid (IWEDA) is automated software that transforms raw weather data into weather intelligence for the battle space commander. IWEDA provides detailed information on the effect weather has on weapon systems, subsystems and components, and operations. This information is tailored to the end user and can provide detailed text explanations and geographic map overlays of what and where the impacts are, or simplified colored matrices that provide information about them. Over the past year, the Army Research Laboratory (ARL) has made significant enhancements to the software and ported it from the personal computer to a Sun Spare 20 Workstation under XWindows. These efforts primarily relate to the initialization of IWEDA with output from ARL Battlescale Forecast Model (BFM) and Atmospheric Sounding Program (ASP) and the inclusion of a realistic map background at various scales. Efforts have also been made to include Navy and Air Force weapon systems in the expansion. Future plans include the integration of output from additional Army decision aids to be used as input in the IWEDA decision-making process as well as a rule editor that allows users to tailor weather impact rules for their operations.

Introduction

In 1991, the Science and Technology Corporation (STC) proposed a work effort to the then Atmospheric Sciences Laboratory to integrate portions of three existing automated weather effects tactical decision aids (TDA) and create a new IWEDA. In the subsequent five years, BED of ARL, along with their contractors STC and the Physical Science Laboratory of New Mexico State University, have developed IWEDA into a powerful tool that allows battlefield commanders to query specific information regarding the effects weather has on weapon systems and operations.

Because papers on IWEDA have been published in previous Battlespace Atmospheric Conferences (BAC) proceedings, an exhaustive overview of the software is not be presented here. Instead, the remainder of the paper focuses on the current status of the software and planned enhancements.

Current Status

Personal Computer Version

The work that began in 1991 on the Army IWEDA, was completed in early 1995 and contains 71 weapon systems (along with additional subsystems and components), and over 500 weather effects rules. Because this version of IWEDA contains systems also of interest to the Air Force and Marines, the software has been requested and distributed to numerous tri-service units throughout the Department of Defense.

In 1996, the Air Force expressed an interest in having the BED modify IWEDA to be more applicable for Air Force weapon systems. As a result, the Air Force funded an effort to develop a prototype IWEDA to include 13 Air Force systems (primarily fixed-wing aircraft). BED collected the pertinent rules for these systems and included the threat anti-air systems from the Army IWEDA. In addition to the data collection effort, the IWEDA database had to be modified to include several new environmental parameters that were not apart of the existing IWEDA. These parameters are flight level visibility, thunderstorm severity, and time of day. The software was delivered, installed, and Air Force personnel were trained at the Air Force Combat Weather Center at Hurlburt Field, Florida, in July of 1996. Testing and evaluation of the software is nearly complete.

UNIX/XWindows Version

Because the Army's common hardware/software platform for tactical field operations at most echelons is a UNIX-based platform, efforts were initiated in early 1995 to port and enhance the PC version to a Hewlett Packard 700 series workstation. The fact that the Army's Integrated Meteorological System (IMETS) is a UNIX-based system also weighed heavily in the decision to rehost IWEDA.

Although the PC version of IWEDA provided an opportunity to solicit feedback on the functionality of the software, it became apparent early in the software development effort that there would beat least two significant deficiencies. These

were primarily a function of the computing power and display limitations of the PC several years ago and included:

Manual weather data entry of all of the required IWEDA input parameters (approximately 30). While this provided flexibility for the user in not having to rely on being connected to a weather data source, it proved to be almost overwhelming to expect users to enter values for all of the parameters for all forecast periods and regions. Due to the time required for users to enter this data and the limitations of the PC to process hundreds of forecast regions, IWEDA limited the user to a maximum of eight forecast regions and six forecast periods. In turn, this resulted in poor resolution of weather impacts due to the limited number of forecast regions.

Crude map graphics. Primitive MS-Windows tools were provided to the user to draw geographic features on a blank map background. The tools were limited to lines, ellipses, polygons, and text. Because of memory constraints, only 15 to 20 of the geographic features could be added to any given map. Although this did provide a frame of reference for the user to determine the general geographic distribution of the weather impacts, it was at best adequate for the interim. As a result, all efforts shifted to the development of the UNIX/XWindows version in 1995 (with the exception of the Air Force funded PC effort in 1996). This effort proved to be challenging, and was compounded by a mandated switch from the Hewlett Packard platform to a Sun Spare 20 Workstation in early 1996, and resulted in an initial version of IWEDA on the new hardware/software platform in June of 1996. The significant features of this software are:

Use of a commercial relational database management system (RDBMS) - INFORMIX - for all database tables and queries. Raw meteorological data is stored in a gridded meteorological database (GMDB) from which embedded structured query language (ESQL) calls are made to create an impacts table to store the grid locations and times for all IWEDA thresholds that have been exceeded. The GMDB is an INFORMIX binary large object created from meteorological data, output from BED's BFM, ASP, and WeatherMaker (a separately developed software application to allow a user friendly method of supplementing the GMDB with the required IWEDA inputs). ESQL within C programs allows the user to query the database tables through a user friendly graphical user interface to determine what systems are impacted, and when. Additional program functionality allows the user to determine why there are impacts, and where the impacts are occurring or are forecast to occur.

Replace the crude PC map graphics with a realistic digital map background. The maps are Arc Digitized Raster Graphics based and allow the user to choose from

a variety of scales (including 1:5,000,000, which is ideal for displaying mesoscale weather information from the BFM). Software was written to allow the user to click the mouse button on any portion of the map to query why the system is impacted at that location.

Incorporate an automated weather data ingest capability to preclude the user from having to manually enter all weather inputs. IWEDA currently runs for the same location and time as the BFM/ASP. After every BFM/ASP run (typically twice a day), the users are prompted to update the IWEDA impacts table. They are also asked whether or not they would like to run the WeatherMaker application to modify any of the four weather parameters (total snow depth, blowing snow, blowing sand, and precipitation) that are currently not predicted by the BFM or ASP. This allows for a much more detailed resolution of the weather impacts as the BFM is typically run on a 51 by 51 grid (yielding 2601 unique points as opposed to the maximum eight regions on the PC). The BFM/ASP currently runs to 24 h.

Support of a client/server architecture. IWEDA can provide the impacts table to other Battlefield Functional Area (BFA) nodes upon request, in support of the Army's Brigade Task Force XXI. The IWEDA binary is located on the individual BFA, which allows for fast response once the required INFORMIX tables have been loaded onto the client. It takes only minutes to transfer the required tables, both over a local area network and surrogate data radios.

To expand the tri-service applicability of IWEDA, a proposal was made to the Office of Naval Research (ONR) in late 1995 to develop a prototype Navy version of the software. This IWEDA would have Navy-specific weapon systems, platforms, and rules. ONR subsequently approved this proposal and funded BED (early 1996) to develop a UNIx/XWindows version for them. Efforts to date have focused on porting/enhancing the PC version to the Sun Spare 20 and collecting rules for the Navy platforms/systems. At the time that this paper was written, neither the commercial RDBMS to use (INFORMIX, Oracle, or Sybase), the map server, or the location for the software to be delivered and installed, had yet been identified. IWEDA will also be an integral part of the next major software upgrade for the IMETS (Block II). Testing and evaluation of the IMETS Block II software and hardware begins in early 1997.

Future Status

PC Version

There are no plans to modify the PC IWEDA software. Based on limited BED resources, all efforts will focus on the UNIX/X Windows version. Any additional work on the PC version would have to be supported by external resources.

UNIX/XWindows Version

Although a tremendous amount of progress has been made over the last year and a half in terms of the porting and enhancing of the PC IWEDA to the Hewlett Packard and Sun Spare 20 workstation environment, several critical tasks remain to be completed.

Design and implementation of a dynamic rule editor. As IWEDA currently exists, there is only one set of critical environmental threshold rules for all users. Although these values serve their purpose as defaults, it became apparent early in the IWEDA development that users require a method for tailoring these values for their unit's application. Several issues must be resolved before a complete design can be attempted:

1. Are all users allowed to edit the IWEDA rules or only a subset of users? For example, can every BFA within a unit edit the rules, or only a designated BFA who is then responsible for creating and maintaining the common database for the unit?
2. Is the current client server architecture with the INFORMIX tables (or Oracle for the All Source Analysis System BFA) maintained on all BFA, or do we change to an architecture where all database tables reside on the server (that is, IMETS)? If the current architecture is maintained, then the rules table modified via the dynamic rule editor must reside on the individual BFA hardware. If not, IMETS must have some way of maintaining and keeping track of multiple rules tables. A change in architecture is considered because software maintenance and distribution for the BFA becomes simpler in certain aspects with all tables only on the server. However, a drawback is that all SQL IWEDA calls are made on the server. The issue of connectivity also becomes more critical (if the network or radio communications go down, the BFA will be unable to run IWEDA).
3. Are user-modified impacts flagged for display to the user? That is, any IWEDA systems that contained one or more edited rules would appear in a different font color or style for a quick visual indicator that this system's weather effects are not based on the default values. An initial dynamic rule

editor is anticipated for IWEDA in FY98. A follow on effort will focus on allowing users to add new systems to the database in addition to editing rules for existing systems.

Incorporate quantitative tactical decision aid output as IWEDA input. IWEDA currently contains numerous rules that are general indicators of weapon system performance. For example, if visibility is less than 1000 m, night vision goggle (NVG) use is flagged as marginal. In reality, the NVG performance is a more complex function of ambient illumination. BED has an illumination module that predicts ambient illumination as a function of cloud amount, cloud type, precipitation, etc. This module would be run at all IWEDA grids(51 by51) and then compared to a new NVG rule that relates performance to illumination. Likewise, existing electro-optics tactical decision aids could be used to compute target recognition and detection ranges at every gridpoint and used in IWEDA rules for target acquisition devices. The illumination module incorporation is anticipated in FY98, the EOTDA incorporation in FY99.

Incorporate the IWEDA map overlays into the common map display used by the individual BFA. Because of initial time constraints, IWEDA was coded to use its own map display, which is separate from the BFA map display window. As a result, IWEDA cannot insert any map overlays into the stack of overlays shared by other applications. Whether this is done via the current map display software (the Army's Terrain Evaluation Module) or the Joint Mapping Tool Kit (JMTK) will be determined by the availability of the JMTK, and the decision made by the Army on whether or not to use JMTK for the BFA. This functionality will be available in either FY97 or FY98.

Complete ONR IWEDA. This is slated for FY97 and will include the collection of rules specifically for Navy and/or Marine systems and platforms. Tasks related to the rewrite of the ESQL code for Oracle or Sybase and the map display are also likely.

Continue support for Brigade Task Force XXI. Although the actual exercise is not until March of 1997, BED personnel have been heavily involved in the software integration, testing, training, and support since May of 1996.

Division XXI Support. This will be a follow-up to the Brigade Task Force XXI and is scheduled for the fall of 1997. Early indications are that there will be no time off (in terms of BED support) between the Brigade and Division exercises. Division XXI support is expected to continue into early FY98.

Summary

A software application has been developed to transform raw weather data into weather intelligence for the battlespace commander. IWEDA has proven itself to bean extremely valuable tool for users, as indicated by their feedback and demand for the application. Although IWEDA has primarily Army weapon systems in its database, the ONR work and addition of a dynamic rule editor should allow for expanded applicability within the tri-service community. A number of other new capabilities will provide an even more powerful tool for the planning and analysis of weapon systems on the battlefield.